ADA

SYNTHETIC FUEL BLEND DEMONSTRATION PROGRAM AT FORT BLISS, TEXAS

INTERIM REPORT
TFLRF No. 407

by
Ruben Alvarez
Adam C. Brandt
Edwin A. Frame

U.S. Army TARDEC Fuels and Lubricants Research Facility
Southwest Research Institute® (SwRI®)
San Antonio, TX

Patsy A. Muzzell
National Automotive Center
U.S. Army RDECOM
Warren, MI

for
U.S. Army TARDEC
Force Projection Technologies
Warren, Michigan

Contract No. DAAE-07-99-C-L053 (WD23-Task XII)

May 2010

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14. ABSTRACT

A 25-vehicle field demonstration test using a JP-8/FT SPK fuel blend was conducted at Ft. Bliss, Texas. The fuel blend prepared for Ft. Bliss contains 48%V FT SPK and 52%V JP-8. Density of the blend was 0.7766. The vehicle fleet included a variety of high-density Army wheeled vehicles and was conducted over a 12-month duration. An equal number of like control vehicles were used for comparison against vehicles using the FT SPK/JP-8 blend. The data acquired during this demonstration consisted of overall engine performance, vehicle operation and maintenance, general fuel economy, and assessment of exhaust smoke opacity readings. Overall fleet performance remained satisfactory to operators and mechanics throughout the test duration. Mechanically the vehicles performed equally well with FT SPK/JP-8 blend and 100% JP-8. The test vehicles logged a total of 47,500 miles and consumed 9,539 gallons of blended fuel while the control vehicles were driven 39,020 miles and consumed 6,908 gallons of JP-8 fuel.

15. SUBJECT TERMS FT SPK, JP-8, Fuel Economy, Blended Fuel, Demonstration Program, Army Wheeled Vehicles, Smoke Opacity

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EXECUTIVE SUMMARY

Problems and Objectives:

Fischer-Tropsch (FT) synthetic fuel can be produced from various resources such as natural gas, coal, biomass, or other carbon-containing streams. In each case, the starting resource must first be converted to synthesis gas consisting of mainly carbon monoxide and hydrogen. From there, this gas can then be converted to long-chain liquid hydrocarbons via the FT reaction. A commonly used acronym for conversion of synthesis gas to these FT-derived liquid hydrocarbons is "GTL", although some use this acronym to mean the conversion of natural gas to FT-derived liquid hydrocarbons; similarly, the acronyms commonly used for coal and biomass are "CTL" and "BTL", respectively. FT-derived fuels will contain no sulfur, and when a low-temperature FT reaction using a cobalt-based catalyst is used, the fuels will also contain no aromatic compounds. On the other hand, petroleum-derived fuels do typically contain both sulfur and aromatics; it is these differences between the "clean" FT fuels and petroleum fuels that raise some issues, particularly with respect to: (1) adequate lubrication of some engine fuel systems and other equipment; and (2) maintaining enough seal swell to avoid leakage when fuel systems are switched between petroleum and synthetic fuels. The objective of this program was to develop comparative data of the performance of high-density tactical wheeled vehicles operating on a blend of Fischer-Tropsch Synthetic Paraffinic Kerosene (FT SPK) and JP-8 fuel.

Importance of Project:

The U.S. military, as the world's single largest user of fuel, consumes several billion gallons per year; therefore, the Department of Defense has shown a keen interest in synthetic fuels because they can lessen the dependence on foreign oil and reduce the environmental impact when manufactured in such a way as to result in lower lifecycle greenhouse gas emissions than current fuels. Also, properties of synthetic and petroleum fuel blends have shown to be similar to those of petroleum JP-8 fuel. The successful demonstration of a JP-8 and synthetic fuel blend in high-density tactical vehicles was an important and necessary step in determining the viability of using a synthetic alternative fuel.

Technical Approach:

This field demonstration program was conducted at Ft. Bliss, Texas for a period of one year. The U.S. Army RDECOM-TARDEC Alternative Fuels Team located at the National Automotive Center in Warren, MI funded the program, while the Command of the 6th ADA Brigade supported the field demonstration at Ft. Bliss. The 1/56th Battalion was tasked to provide the vehicles that participated in the demonstration program. The field demonstration was designed so that it would not impact the normal mission/training activities; including personnel, workload, or equipment. The following types of vehicles were included in the demonstration:

- 22 Ton Line Haul Trucks
- 10 Ton HEMTT
- 5 Ton Truck M925
- 5 Ton Truck MTV
- 2½ Ton Truck LMTV
- 1¼ Ton Truck HMMWV

Vehicles selected for the demonstration program were divided into two groups. One designated as the test vehicles and the other designated as the control vehicles. The test and control groups were composed to the greatest extent possible of the same number and type of vehicles. In addition, test and control vehicles were assigned to the same unit so that both groups were operated under the same duty cycles. Fueling areas were set up at opposite ends of the motor pool for the different fuels to help avoid cross-contamination. An existing 10,000-gallon tank and metered dispensing station was used to fuel the control vehicles with JP-8, and an M969A1 5,000-gallon semi-trailer fuel-dispensing tanker was used to fuel the test vehicles with the blend of synthetic fuel FT SPK and JP-8. The blend contained 48% synthetic fuel, and was transported to Ft. Bliss from the TARDEC Fuels and Lubricants Research Facility in San Antonio, TX.

New calibrated fuel injection pumps and injectors were installed by TARDEC Fuels and Lubricants Facility (TFLRF) personnel at the beginning of the demonstration on three test HMMWV trucks. The intent for this action was to remove the pumps and injectors at the end of the program to compare the start and end of test calibration results. The removed fuel components on all HMMWVs would be reinstalled in the vehicles at the conclusion of the demonstration. At the completion of testing, only one HMMWV had accumulated enough miles to warrant removal of fuel components for analysis. The remaining two HMMWVs did not accumulate enough miles to justify post-test analysis and the new pumps and injectors remained installed in the vehicles.

Accomplishments:

Test vehicles accumulated in excess of 47,000 miles and consumed 10,000 gallons of FT SPK /JP-8 blend, and the control vehicles accumulated in excess of 39,000 miles and consumed 7,000 gallons of 100% JP-8 fuel during the program. There were no performance problems reported, nor any deficiencies noted at end of test inspection of the vehicles. The demonstration progressed seamlessly and efficiently without any operational or logistical problems.

Military Impact:

U.S. military installations continue to provide an excellent avenue to introduce alternative fuels. Therefore, the data accumulated during this demonstration program can be used in the decision-making process of introducing FT SPK /JP-8 blended fuel in Army installations around the globe.

FOREWORD/ACKNOWLEDGMENTS

This work was performed by the U.S. Army TARDEC Fuels and Lubricants Research Facility (TFLRF) located at Southwest Research Institute (SwRI), San Antonio, Texas, during the period of July 2008 through April 2010 under Contract No. DAAE07-99-C-L053. The work was funded by the U.S. Army RDECOM-TARDEC Alternative Fuels Team and administered by the U.S. Army Tank Automotive Research, Development and Engineering Center, Force Projection Technologies, Warren, Michigan. Mr. Luis Villahermosa (AMSTA-RDTA-DP) served as the TARDEC contracting officer's representative, and Ms. Patsy A. Muzzell as project technical monitor.

The authors would like to acknowledge the assistance provided by Mr. Jose Valverde, Chief, DOL Maintenance Division, Ft. Bliss, Texas, for his untiring support throughout the demonstration program. Also special mention is given to Mr. Marcos Padilla, Supervisor, 88th Maintenance Support Group for his enthusiasm, genuine interest, and willingness to support the field demonstration program.

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TABLE OF CONTENTS

Section **Page**

EXECUTIVE SUMMARY v
FOREWORD/ACKNOWLEDGMENTS viii
TABLE OF CONTENTS ix
LIST OF TABLES x
LIST OF FIGURES x
ACRONYMS AND ABBREVIATIONS xi
1.0 BACKGROUND 1
2.0 INTRODUCTION 1
3.0 PROGRAM OBJECTIVES 2
4.0 DETAILS OF DEMONSTRATION 2
4.1 General 2
4.2 Fleet Vehicle Descriptions 3
4.3 Vehicle Preparations 9
4.4 Data Collection 11
4.5 Test fuels and Refueling Stations 12
4.5.1 FT SPK /JP-8 (Test Fuel) 12
4.5.2 JP-8 (Control Fuel) 14
4.6 Engine Powercurves 16
5.0 RESULTS 20
5.1 General 20
5.2 Vehicle Usage And Fuel Consumption 22
5.3 Fuel System Component Replacement 24
5.3.1 Stanadyne DB2 Rotary Injection pump 24
5.3.2 Fuel Injector Model NA52X 27
5.4 Vehicle Performance 28
5.5 Fuel Quality Analysis 28
5.6 Smoke Opacity Evaluations 30
6.0 CONCLUSIONS 30

LIST OF TABLES

Table **Page**

Table 1 - Description of Test and Control Vehicles 8
Table 2 - FT SPK Fuel Chemical Analysis 13
Table 3 - FT SPK / San Antonio, JP-8 Blend Chemical Analysis 13
Table 4 - Ft. Bliss, TX JP-8 Fuel Chemical Analysis by TFLRF 15
Table 5 – San Antonio, TX, JP-8 Blended From Jet A 16
Table 6 - Caterpillar C7 Powercurve Statistical Analysis 18
Table 7 - GEP 6.5L(T) Powercurve Statistical Analysis 19
Table 8 - Summary of Test and Control Vehicle Data 20
Table 9 - Test and Control Vehicles Added/Removed During Demonstration 23
Table 10 - Pre- and Post-Test Injection Pump Calibration Results 26
Table 11 - Injector Nozzle Test Results 28

LIST OF FIGURES

Figure **Page**

Figure 1 - M998A2 HMMWV 4
Figure 2 - M925A2 5 Ton Cargo Truck 4
Figure 3 - M1078 2.5 Ton LMTV 5
Figure 4 - M1083A1 5 Ton MTV 5
Figure 5 - M1089A1 Truck Wrecker FMTV 6
Figure 6 - M984A1 Truck Wrecker HEMTT 6
Figure 7 - M978A1 Truck Fuel Tanker HEMMTT 7
Figure 8 - M915A4 Truck Tractor Line Haul 7
Figure 9 - Newly Installed Stanadyne Rotary Pump 9
Figure 10 - Fluorescent Orange Marker on Windshield to Identify Test Vehicles 10
Figure 11 - Fluorescent Orange Painted Fuel Cap to Identify Test Vehicle 11
Figure 12 - Test Vehicle Fueling Area 14
Figure 13 - Control Vehicle Fueling Area 15
Figure 14 - Caterpillar C7 FT SPK / JP-8 Maximum Power 17
Figure 15 - Caterpillar C7 FT SPK / JP-8 Maximum Torque 17
Figure 16 - GEP 6.5L(T) FT SPK / JP-8 Maximum Power 18
Figure 17 - GEP 6.5L(T) FT SPK / JP-8 Maximum Torque 19
Figure 18 - Total Mileage Accumulation by Vehicle Type 22
Figure 19 - Average Miles Per Gallon by Vehicle Type 24
Figure 20 - Test Vehicle Fuel Tank Turnover 29

APPENDIX A
Ft. Bliss, TX, Test and Control Vehicle Usage Data

APPENDIX B
Chemical Analyses of Ft. Bliss, TX, JP-8 and JP-8/ FT SPK Fuel Blend

ACRONYMS AND ABBREVIATIONS

ADA	Air Defense Artillery
CST	Centistokes
DA	Department of Army
DOD	Department of Defense
FT	Fischer-Tropsch
FT SPK	Fischer-Tropsch Synthetic Paraffinic Kerosene
GPM	Gallons per Mile
HC	Hydrocarbons
HEMTT	Heavy Expanded Mobility Tactical Truck
HMMWV	High Mobility Multi-Purpose Wheel Vehicle
IPK	Iso-Paraffinic Kerosene
JP-8	Aviation Turbine Fuel
LMTV	Light Medium Tactical Vehicle
MPG	Miles per Gallon
MTV	Medium Tactical Vehicle
POL	Petroleum Oil Lubricant
RDECOM	U. S. Army Research Development and Engineering Command
SWRI	Southwest Research Institute
TARDEC	U.S. Army Tank Automotive Research, Development and Engineering Center
TFLRF	TARDEC Fuels and Lubricants Research Facility
TRADOC	Training and Doctrine Command

1.0 BACKGROUND

Fischer-Tropsch (FT) synthetic fuel can be produced from various resources such as natural gas, coal, biomass, or other carbon-containing streams. In each case, the starting resource must first be converted to synthesis gas consisting of mainly carbon monoxide and hydrogen. From there, this gas can then be converted to long-chain liquid hydrocarbons via the FT reaction. A commonly used acronym for conversion of synthesis gas to these FT-derived liquid hydrocarbons is "GTL", although some use this acronym to mean the conversion of natural gas to FT-derived liquid hydrocarbons; similarly, the acronyms commonly used for coal and biomass are "CTL" and "BTL", respectively. FT-derived fuels will contain no sulfur, and when a low-temperature FT reaction using a cobalt-based catalyst is used, the fuels will also contain no aromatic compounds. [1] On the other hand, petroleum-derived fuels do typically contain both sulfur and aromatics; it is these differences between the "clean" FT fuels and petroleum fuels that raise some issues, particularly with respect to: (1) adequate lubrication of some engine fuel systems and other equipment; and (2) maintaining enough seal swell to avoid leakage when fuel systems are switched between petroleum and synthetic fuels. [2] The U.S. military, as the world's single largest user of fuel, consumes several billion gallons per year; therefore, the Department of Defense has shown a keen interest in synthetic fuels because they can lessen the dependence in foreign oil and reduce the environmental impact due to cleaner burning of the fuel. [3] Also, properties of synthetic and petroleum fuel blends are shown to be similar to those of petroleum JP-8 fuel. [4] The successful demonstration of a JP-8 and synthetic paraffinic kerosene blend in high-density tactical vehicles is an important and necessary step in determining the viability of the use of a synthetic alternative fuel.

2.0 INTRODUCTION

The U.S. Army RDECOM-TARDEC Alternative Fuels Team at the National Automotive Center, Warren, MI, sponsored the field demonstration program conducted at Ft. Bliss, Texas. The TARDEC Fuels and Lubricants Research Facility (TFLRF) at Southwest Research Institute® (SwRI) conducted and monitored the demonstration program. The Command of the 6th ADA Brigade supported the field demonstration, and B Company of the 1/56th Battalion was tasked to provide the vehicles that participated in the demonstration program. The demonstration program was designed so that it would not impact the normal mission/training activities including personnel, workload, or equipment. The following types of vehicles were included in the demonstration:

- 22 Ton Line Haul Trucks (7 Test 4 Control)
- 10 Ton HEMTT (1 Test 1 Control)
- 5 Ton Wrecker FMTV (1 Test 1 Control)
- 5 Ton Truck M925 (5 Test 4 Control)
- 5 Ton Truck MTV (5 Test 5 Control)
- 2½ Ton Truck LMTV (6 Test 7 Control)
- 1¼ Ton Truck HMMWV (3 Test 1 Control)

3.0 PROGRAM OBJECTIVES

The program objectives were:

- To compare vehicle normal duty cycle performance while operating on JP-8 Turbine Fuel and a blend of JP-8 and FT SPK (Fischer-Tropsch Synthetic Paraffinic Kerosene), and determine the viability of using the fuel blend in the Army's high-density wheeled vehicle fleet.
- To quantify vehicle performance, fuel economy, engine performance and maintenance.

4.0 DETAILS OF DEMONSTRATION

4.1 GENERAL

Coordination for support of the program started with the Chief of Maintenance of the Directorate of Logistics at Ft. Bliss, TX. The request was forwarded to the 6th ADA Brigade for its status as a Training and Doctrine Command (TRADOC) unit whose vehicle assets are not deployable. The 6th Brigade Maintenance Activity forwarded the request to TRADOC Headquarters at Ft. Monroe, VA, for consideration and approval. Upon approval, several planning meetings were held to delineate tasking, responsibilities, and the staffing for a program plan entitled "6th ADA Tactical Vehicle Demonstration Program". [5] A command briefing was held at the 6th Brigade Headquarters comprised of personnel from RDECOM-TARDEC, TFLRF, DOL Supply and

Maintenance, Biggs POL, Commanders and staff of the 6th Brigade, B Company, 1/56th Battalion, and management of the 88th Maintenance Support Group.

TFLRF staff visited Ft. Bliss, Texas, on a bi-monthly basis to monitor the demonstration program, collect usage data, obtain used fuel samples, and conduct a visual inspection of the test vehicles for early detection of possible fuel leaks.

4.2 FLEET VEHICLE DESCRIPTIONS

The tactical vehicles used for the demonstration were comprised of the following models: M998A2 HMMWV, M925A2 5 Ton Cargo Truck, M1078 2½ Ton LMTV, M1083A1 5 Ton MTV, M1089A1 Truck Wrecker FMTV, M984A1 Truck Wrecker HEMTT, M978A1 Truck Fuel Tanker HEMTT and M915A4 Truck Tractor Freightliner. The vehicles in the order listed are illustrated in Figure 1 through Figure 8.

Figure 1 - M998A2 HMMWV (U.S. Army Photograph)

Figure 2 - M925A2 5 Ton Cargo Truck (TFLRF Photograph)

Figure 3 - M1078 2.5 Ton LMTV **(TFLRF Photograph)**

Figure 4 - M1083A1 5 Ton MTV **(TFLRF Photograph)**

Figure 5 - M1089A1 Truck Wrecker FMTV **(TFLRF Photograph)**

Figure 6 - M984A1 Truck Wrecker HEMTT **(TFLRF Photograph)**

Figure 7 - M978A1 Truck Fuel Tanker HEMTT **(U.S. Army Photograph)**

Figure 8 - M915A4 Truck Tractor Line Haul **(U.S. Army Photograph)**

Table 1 below lists the characteristics of the test vehicles, including odometer reading, test start date, and fuel type.

Table 1 - Description of Test and Control Vehicles

TEST (T) AND CONTROL (C) VEHICLES						
Bumper Number	Nomenclature	Model Number	Engine Model Number	Start Miles	Start Date	Test Fuel
B 02 T	Truck Utility HMMWV	M998A1	GEP 6.2	134	11/21/08	S-8/JP8
B 03 T	Truck Utility HMMWV	M998A1	GEP 6.2	18024	7/31/08	S-8/JP8
B 04 T	Truck Utility HMMWV	M998A1	GEP 6.2	199	11/21/08	S-8/JP8
B 01 C	Truck Utility HMMWV	M998A1	GEP 6.2	27337	7/31/08	JP-8
B 107 T	Truck Cargo 5Ton	M925A2	Cummins 8.3L	31511	7/31/08	S-8/JP8
B 109 T	Truck Cargo 5Ton	M925A2	Cummins 8.3L	33430	7/31/08	S-8/JP8
B 110 T	Truck Cargo 5Ton	M925A2	Cummins 8.3L	33415	7/31/08	S-8/JP8
B 111 T	Truck Cargo 5Ton	M925A2	Cummins 8.3L	47653	7/31/08	S-8/JP8
B 112 T	Truck Cargo 5Ton	M925A2	Cummins 8.3L	36974	7/31/08	S-8/JP8
B 117 C	Truck Cargo 5Ton	M925A2	Cummins 8.3L	5084	7/31/08	JP-8
B 118 C	Truck Cargo 5Ton	M925A2	Cummins 8.3L	30976	7/31/08	JP-8
B 119 C	Truck Cargo 5Ton	M925A2	Cummins 8.3L	29632	7/31/08	JP-8
B 120C	Truck Cargo 5Ton	M925A2	Cummins 8.3L	24908	7/31/08	JP-8
B 70 T	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	13421	11/21/08	S-8/JP8
B 72 T	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	11743	7/31/08	S-8/JP8
B 73 T	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	11520	7/31/08	S-8/JP8
B 77 T	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	11808	7/31/08	S-8/JP8
B 80 T	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	12468	7/31/08	S-8/JP8
B 82 T	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	10446	7/31/08	S-8/JP8
B 71 C	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	11743	7/31/08	JP-8
B 74 C	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	11068	11/21/08	JP-8
B 75 C	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	12922	11/21/08	JP-8
B 84 C	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	11952	7/31/08	JP-8
B 87 C	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	1818	7/31/08	JP-8
B 88 C	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	11237	7/31/08	JP-8
B 89 C	Truck Cargo 2½Ton LMTV	M1078	Caterpillar 3116	8930	7/31/08	JP-8
B 141 T	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	7266	7/31/08	S-8/JP8
B 144 T	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	8155	7/31/08	S-8/JP8
B 148 T	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	5414	7/31/08	S-8/JP8
B 150 T	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	9161	7/31/08	S-8/JP8
B 154 T	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	9915	7/31/08	S-8/JP8
B 155 C	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	5046	7/31/08	JP-8
B 160 C	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	10356	7/31/08	JP-8
B 161 C	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	6406	7/31/08	JP-8
B 163 C	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	9973	7/31/08	JP-8
B 159 C	Truck Cargo 5Ton MTV	M1083A1	Caterpillar C-7	9712	7/31/08	JP-8
B 55 T	Truck Tractor Line Haul	M915A4	Cummins NTC-400	6052	7/31/08	S-8/JP8
B 58 T	Truck Tractor Line Haul	M915A4	Cummins NTC-400	5570	7/31/08	S-8/JP8
B 65 T	Truck Tractor Line Haul	M915A4	Cummins NTC-400	7281	7/31/08	S-8/JP8
B 67 T	Truck Tractor Line Haul	M915A4	Cummins NTC-400	6211	7/31/08	S-8/JP8
B 126 T	Truck Tractor Line Haul	M915A4	Cummins NTC-400	11986	11/21/08	S-8/JP8
B 136 T	Truck Tractor Line Haul	M915A4	Cummins NTC-400	9889	7/31/08	S-8/JP8
B 137 T	Truck Tractor Line Haul	M915A4	Cummins NTC-400	11988	7/31/08	S-8/JP8
B 59 C	Truck Tractor Line Haul	M915A4	Cummins NTC-400	5165	7/31/08	JP-8
B 66 C	Truck Tractor Line Haul	M915A4	Cummins NTC-400	5678	7/31/08	JP-8
B 135 C	Truck Tractor Line Haul	M915A4	Cummins NTC-400	9853	7/31/08	JP-8
B 138 C	Truck Tractor Line Haul	M915A4	Cummins NTC-400	16253	7/31/08	JP-8
B 301 T	Truck Wrecker FMTV	M1089A1	Caterpillar C-7	867	7/31/08	S-8/JP8
B 302 C	Truck Wrecker FMTV	M1089A1	Caterpillar C-7	1129	7/31/08	JP-8
B 300 T	Truck Wrecker HEMTT	M984A1	DD 8V92TA	11429	7/31/08	S-8/JP8
B 93 C	Truck Fuel Tanker HEMTT	M978	DD 8V92TA	18426	7/31/08	JP-8

4.3 VEHICLE PREPARATIONS

Vehicle inspections were conducted on all test and control vehicles prior to the commencement of the demonstration program. Inspections consisted of a thorough visual check of all fuel lines and fuel-wetted components to insure that no leaks were evident prior to the use of the FT SPK/JP-8 blend. Smoke opacity readings at transmission stall speed were conducted to observe changes from start of test to EOT. These inspections were repeated quarterly throughout the test.

Of significant concern, was leakage and performance problems exhibited in test vehicles equipped with rotary injection pumps while using the blended FT SPK/JP-8 fuel. Therefore, new calibrated fuel injection pumps and fuel injectors were installed in only the three test HMMWV trucks to observe changes in calibration flows and pressures results between start and end of test. One HMMWV designated as control was operated as found, and would continue to be monitored for mileage accumulation, fuel consumption, and performance like the rest of the control vehicles in the demonstration program. Figure 9 below shows a newly installed Stanadyne rotary injection pump in one of the test HMMWVs.

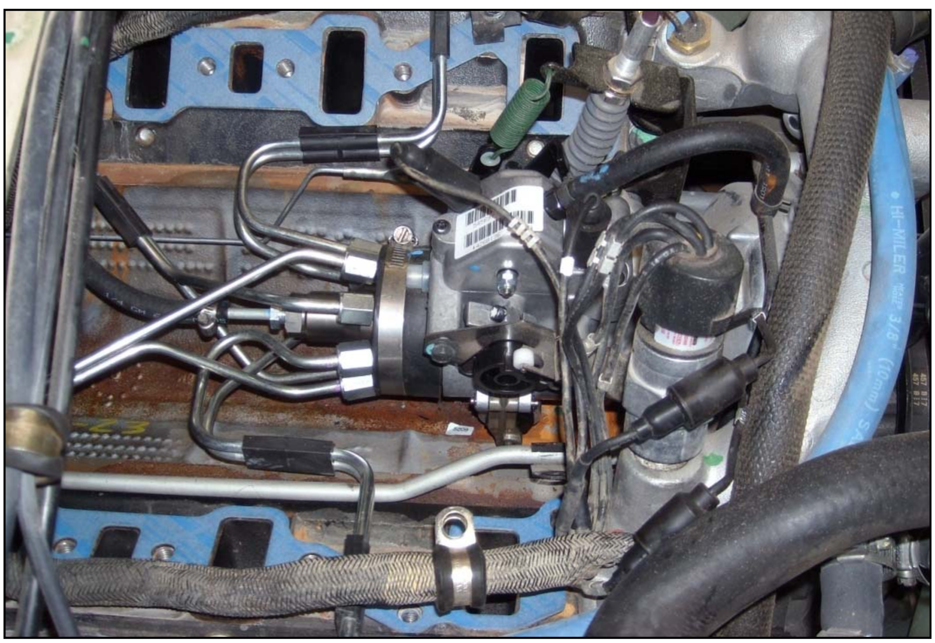

Figure 9 - Newly Installed Stanadyne Rotary Pump

Test vehicles were marked on the top right side of the windshield with a bright orange fluorescent circle with a black "T" stenciled in the middle, and the fuel caps were painted fluorescent orange to insure that test vehicles were fueled with the blended fuel. Figure 10 shows the orange circle and black "T" on the windshield of the vehicle, while Figure 11 shows the bright orange fuel cap.

Figure 10 - Fluorescent Orange Marker on Windshield to Identify Test Vehicles

Figure 11 - Fluorescent Orange Painted Fuel Cap to Identify Test Vehicle

4.4 DATA COLLECTION

Arrangements were made to have the records section provide monthly usage data as entered into the unit data system. However, it was learned that the majority of the vehicles were operating at remote sites outside of the motor pool area and were dispatched weekly and or monthly. Usage data was entered into the system when the vehicle was re-dispatched; therefore it was found that the data in the system was not current during the bi-monthly visits. To insure the usage data coincided with the program visits, the following procedure for collecting data was initiated:

- TFLRF staff would physically record odometer mileage readings from each test and control vehicle at every monitoring visit.
- Copies of the DA Form 3643 (Daily Issues Of Petroleum Products) were provided to TFLRF staff at every site visit for calculation of total gallons dispensed during a given period. Unit POL personnel maintained daily DA Form 3643 on each vehicle fueled with the synthetic fuel blend or JP-8 fuel.
- TFLRF staff collected used fuel samples from all test vehicles and seven randomly selected control vehicles during scheduled site visits. Samples from the JP-8 and blended fuel dispensing tanks were also collected. All samples were shipped to TFLRF for analyses per established protocol.

- Quarterly physical inspections of fuel-wetted components and smoke opacity readings were conducted and recorded on all test and control vehicles.

4.5 TEST FUELS AND REFUELING STATIONS

4.5.1 FT SPK/JP-8 (Test Fuel)

The synthetic blended fuel was composed of FT process-derived Synthetic Paraffinic Kerosene blended with petroleum-based aviation turbine fuel (JP-8). A 52/48 blend of JP-8/FT SPK achieved the required specification for minimum density per MIL-DTL-83133F. The synthetic fuel blend was treated with DCI-4A CI/LI so that the overall fuel blend contained the maximum rate of 22.5 mg/L per QPL-25017. [6] Table 2 shows properties of neat FT SPK while Table 3 shows the properties of the blended FT SPK/JP-8 fuel at Ft. Bliss.

Table 2 - FT SPK Chemical Analysis

Property	Test Method	Result		Property Cont.	Test Method	Result
Density, 15°C g/ml	D4052	0.755		Distillation (°C)	D86	
Kinematic Vis @ 40°C cSt	D445	1.35		IBP		159
Sulfur, ppm	D2622	< 1		10		171
Hydrocarbons by FIA	D1319			20		177
Aromatic, vol%		0.5		50		201
Olefin, vol%		0.5		90		248
Saturates, vol%		99		FBP		272
Net BTU (BTU/lb)	D93	18907		Cetane Number	D613	61
Flash Point (°F) (C)	D93	114.8/46		Calculated Cetane	D976	64
SLBOCLE, g	D6078	750		IQT	D6890	58
BOCLE, mm	D5001	98		Particulate Contamination	D5452	
HFRR,µm	D6079	0.559		Total Volume, L		1
				Total Contamination, mg/L		<0.1mg/L
				Hydrogen	D5291	15.2

Table 3 - FT SPK / JP-8 Blend Chemical Analysis

Property	Test Method	Result		Property Cont.	Test Method	Result
Density, 15°C g/ml	D4052	0.7809		Distillation (°C)	D86	
Kinematic Vis @ 40°C cSt	D445	1.12		IBP		161.4
Sulfur, wt%	D2622	< 1		10		171.0
Hydrocarbons by FIA	D1319			20		174.4
Aromatic, vol%		10.5		50		187.1
Olefin, vol%		1		90		223.1
Saturates, vol%		88.5		FBP		245.4
Heat Of Combustion	D240			Cetane Number	D613	49.9
Gross BTU (BTU/lb)		19967.4		Calculated Cetane	D976	46.6
Net (BTU/lb)		18645.4		IQT	D6890	48.2
Flash Point (°F) (C)	D93	124/51		Particulate Contamination	D5452	
SLBOCLE, g	D6078	2200		Total Volume, L		1
BOCLE, mm	D5001	0.55		Total Contamination, mg/L		<0.1mg/L
HFRR,µm	D6079	0.631		Water Content, ppm	D6304	69
				Carbon	D5291	85.6
				Hydrogen	D5291	14.5

The FT SPK /JP-8 blend fueling station was located within an environmental containment area at the southeast end of the motor pool. A 5,000 gallon capacity fuel dispensing M969A1 semitrailer tank was used as a temporary facility for the duration of the demonstration program. The semitrailer tank was hand receipted from USAR 385th Transportation Battalion and was used throughout the testing duration and was professionally flushed and cleaned upon return to the reserve unit. The semitrailer tank was located within a containment area. During fueling operations, the test vehicles were driven adjacent to the semitrailer refueling tank in order to utilize the containment area while refueling. The environmental containment was supplied by a concrete beam that surrounded the tanker parking area. In addition, the fueling area included the appropriate static grounding equipment needed for safe operations. Figure 12 shows the FT SPK /JP-8 blend fueling station where test vehicles were fueled.

Figure 12 - Test Vehicle Fueling Area

4.5.2 JP-8 (Control Fuel)

The JP-8 fuel used by the control vehicles is produced at the Western Refinery and piped into Ft. Bliss from Holloman Air Force Base at Alamogordo, NM. Properties from samples obtained from the motor pool storage tank are shown in Table 4.

Table 4 - Ft. Bliss, TX JP-8 Fuel Chemical Analysis by TFLRF

Property	Test Method	Result		Property Cont.	Test Method	Result
Density, 15°C g/ml	D4052	0.8049		Distillation (°C)	D86	
KinematicVis@ 40°C cSt	D445	1.25		IBP		151.7
Sulfur, wt%	D2622	0.0982		10		168.2
Hydrocarbons by FIA	D1319			20		175.9
Aromatic, vol%		16.6		50		196.5
Olefin, vol%		1.3		90		241.9
Saturates, vol%		82.1		FBP		274.2
Heat Of Combustion	D240			Cetane Number	D613	42.1
Gross BTU (BTU/lb)		19783		Calculated Cetane	D976	40.8
Net (BTU/lb)		18524		Particulate Contamination	D5452	
Flash Point (°F) (C)	D93	129/53.3		Total Volume, L		1.00
SLBOCLE, g	D6078	2800		Total Contamination, mg/L		0.40
BOCLE, mm	D5001	0.55		Water Content, ppm	D6304	48
HFRR,µm	D6079	789				

The JP-8 fueling station consisted of an existing 10,000 gallon permanently installed steel tank with attached fuel pumping and metering apparatus located within the motorpool. Like the test fuel, the control fueling station had a surrounding environmentally approved fuel containment berm and appropriate static grounding equipment. Figure 13 shows the JP-8 fueling station for control vehicles.

Figure 13 - Control Vehicle Fueling Area

4.6 ENGINE POWERCURVES

Prior to initiating testing on site, engine powercurves were completed on two high density engines represented in the field demonstration. These included the General Engine Products (GEP) 6.5L(T), and the Caterpillar (CAT) C7 engine. The GEP 6.5L(T) engine utilizes a fuel-lubricated rotary style injection pump in a pump line nozzle configuration, while the CAT C7 engine uses a hydraulically actuated, electronically controlled unit injection system (HEUI). Due to variation in fuel properties between the FT SPK/JP-8 blend and 100% JP-8, there is a potential to experience changes in specific power output of the engines due to the fuels interactions with the fuel system hardware. To verify any potential changes in engine power, full load powercurves were run on each engine using the FT SPK/JP-8 blend as used in the field demonstration, and 100% JP-8 blended from Jet A at SwRI. As seen below in Table 5, fuel properties of the JP-8 used in engine powercurve testing differed from JP-8 supplied at Ft. Bliss. This can also affect the engine powercurves, but can still be used as a representative comparison to determine approximate power loss expected between JP-8 and the FT SPK/JP-8 blend.

Table 5 – San Antonio, TX, JP-8 Blended From Jet A

Property	Test Method	Result		Property Cont.	Test Method	Result
Density, 15C (g/mL)	D4052	0.8144		Distillation	D86	
Kinematic Viscosity, 40C (cSt)	D445	1.29		IBP		171.4
Sulfur (wt%)	D2622	0.0027		10		184.9
Hydrocarbons by FIA	D1319			20		189
Aromatic (vol%)		16.9		50		199.9
Olefin (vol%)		2.7		90		225.8
Saturates (vol%)		80.4		FBP		247.3
Heat of Combustion	D240			IQT	D6890	38.79
GROSS (BTU/lb)		19706.7				
NET (BTU/lb)		18470.5				
Flash Point (°F)	D93	134				
(°C)		56.7				
SLBOCLE (g)	D6078	3550				
BOCLE (mm)	D5001	0.46				
HFRR (µm)	D6079	702				

Figure 14 and Figure 15 below shows the full load horsepower and torque curves of the CAT C7 engine for both fuels.

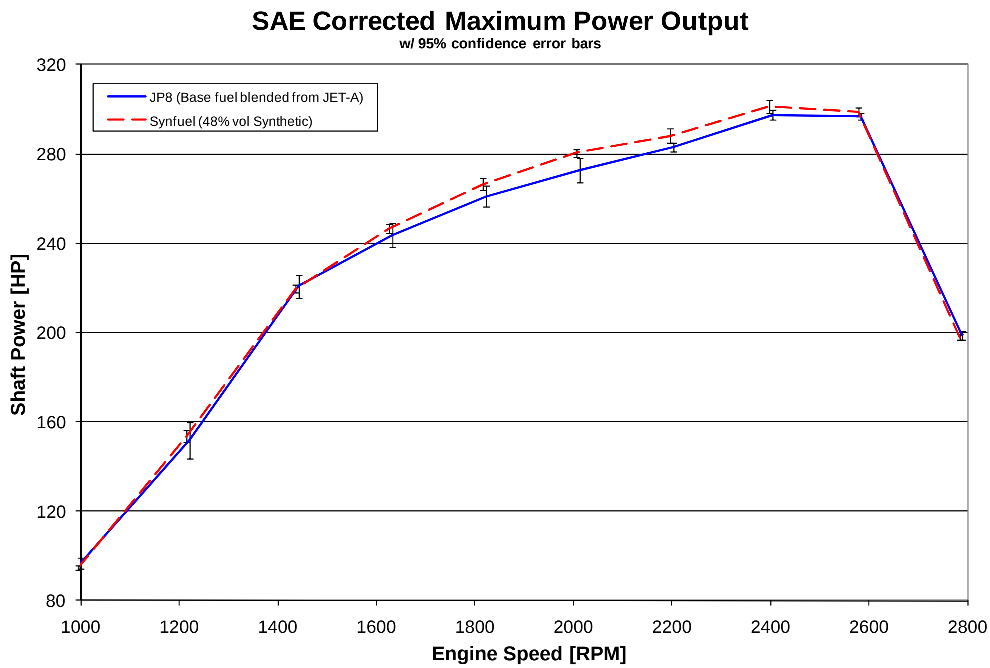

Figure 14 - Caterpillar C7 FT SPK / JP-8 Maximum Power

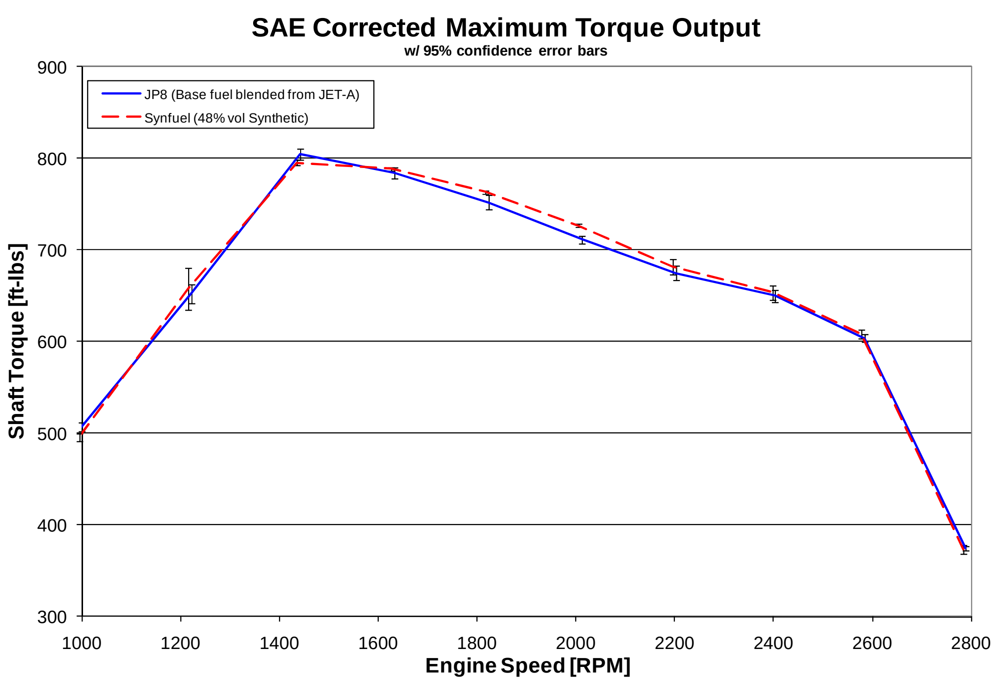

Figure 15 - Caterpillar C7 FT SPK / JP-8 Maximum Torque

As seen in Table 6, the 1.3% change in peak power and -1.1% change in peak torque was not found to be significant on the 95% confidence interval. This supported that the fuel could be changed in the test vehicles without causing operator dissatisfaction with overall vehicle performance.

Table 6 - Caterpillar C7 Powercurve Statistical Analysis

		Peak Power @ 2400 RPM			Peak Torque @ 1400 RPM	
Fuel Density		**Power, [hp]**	**Delta**		**Torque, [ft lbs]**	**Delta**
0.8144	**Blended JP8**	297.58		**Blended JP8**	804.85	
0.7766	**Synfuel**	301.32	1.3%	**Synfuel**	795.78	-1.1%
		Significant on 95% CI	NO		**Significant on 95% CI**	NO

Figure 16 and Figure 17 below shows the full load horsepower and torque curves of the GEP 6.5L(T) engine for both fuels.

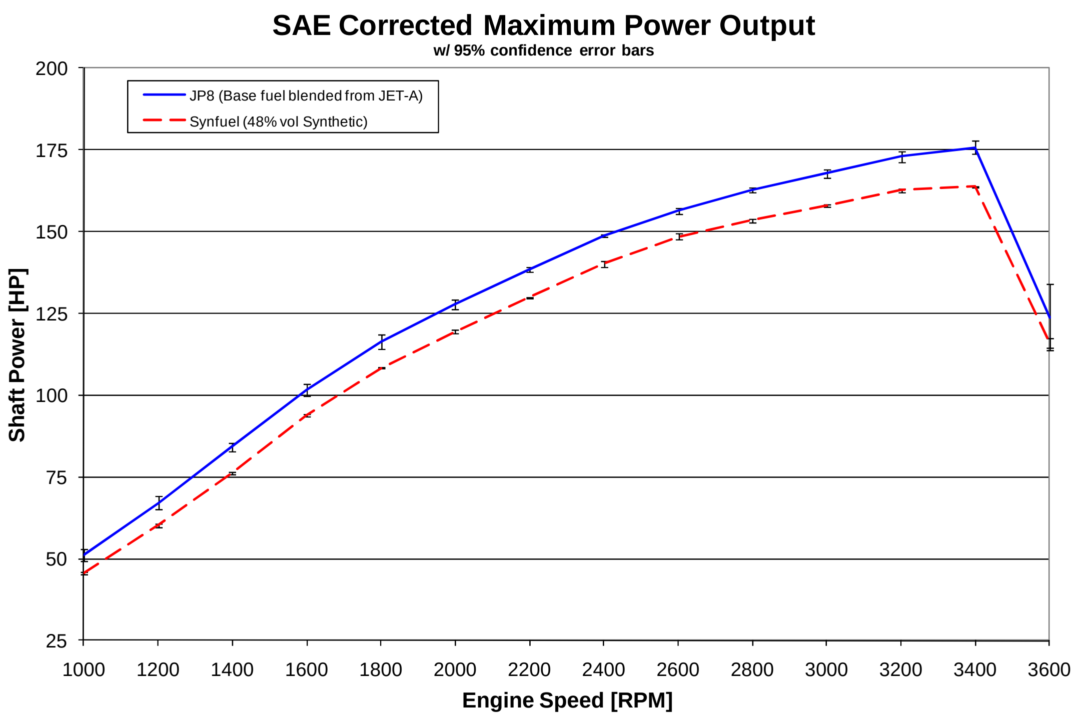

Figure 16 - GEP 6.5L(T) JP-8 & FT SPK/JP-8 Maximum Power

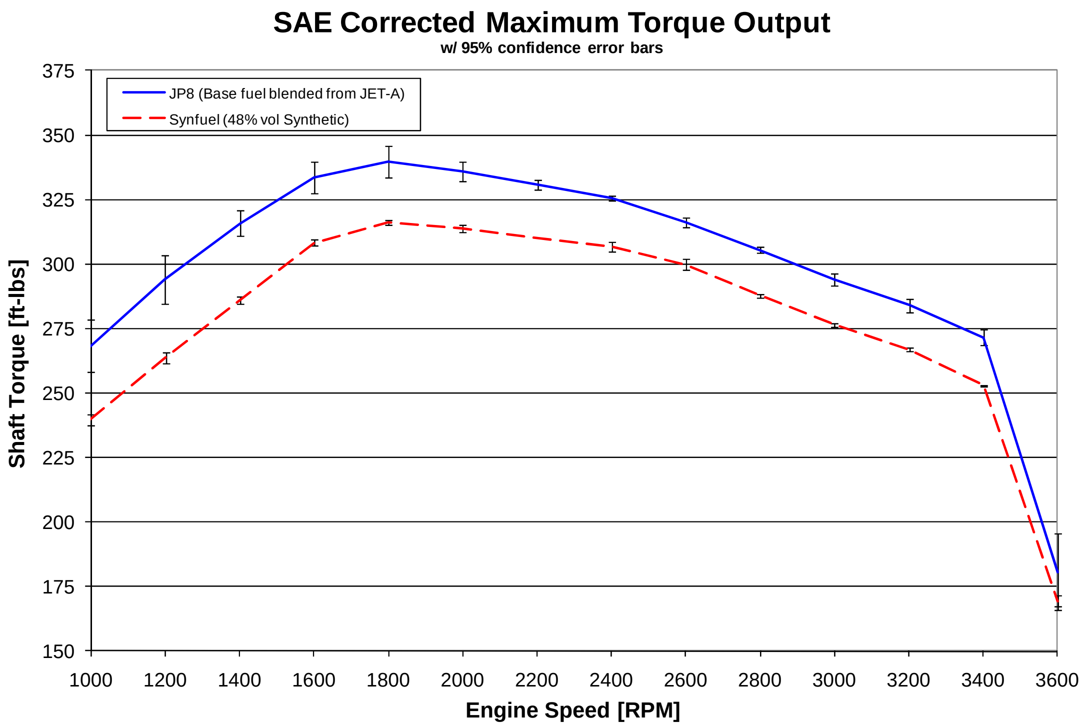

Figure 17 - GEP 6.5L(T) JP-8 & FT SPK/JP-8 Maximum Torque

Unlike the CAT C7, changes in the GEP 6.5L(T) peak power and torque were found to be significant on the 95% confidence interval as shown below in Table 7. This variance in power is attributable to the 6.5L(T) rotary pumps sensitivity to the varying density, viscosity, and bulk modulus of the FT SPK/JP-8 blend when compared to 100% JP-8. The 7% negative difference in power and torque with the synthetic fuel blend was not noticeable in actual operation during the field demonstration, and no performance problems were reported by operators or maintenance personnel.

Table 7 – GEP 6.5 Powercurve Statistical Analysis

	Power @ 3400			Torque @ 1800		
Fuel Density		**Power [HP]**	**Delta**		**Torque [ftlb]**	**Delta**
0.8144	**Blended JP8**	175.79		**Blended JP8**	339.67	
0.7766	**Synfuel**	163.73	-6.9%	**Synfuel**	315.94	-7.0%
		Significant on 95% CI	YES		**Significant on 95% CI**	YES

5.0 RESULTS

5.1 GENERAL

The test and control vehicles accumulated in excess of 86,000 miles of operation from August, 2008 through June, 2009. Test vehicles accumulated 47,000 miles of operation and control vehicles logged 39,000 miles of operation. 9,500 gallons of synthetic fuel blend were used by the test vehicles while the control vehicles used 6,900 gallons of JP-8. The demonstration program was initially scheduled to terminate on August 2009; however the transportation school suspended classes at Ft. Bliss sooner than initially scheduled, and test and control vehicles used for the demonstration program were shipped to Ft. Leonard Wood, MO. Therefore, the demonstration was suspended in June 2009 after eleven months of testing. A summary of individual vehicle usage and fuel economy data for test and control vehicles is presented in Table 8.

Table 8 - Summary of Test and Control Vehicle Data

Vehicle Type	Bumper Number	Total Miles	Total Gallons	Miles/ Gallon	Gallon/ Miles	Fuel Type
HMMWV	B 02 T	365	63	5.8	0.17	S-8/JP-8
HMMWV	B 03 T	4968	483	10.3	0.10	S-8/JP-8
HMMWV	B 04 T	321	63	5.1	0.2	S-8/JP-8
HMMWV	B 01 C	1642	181	9.1	0.11	JP-8
5 Ton Truck	B 107 T	3053	612	5.0	0.20	S-8/JP-8
5 Ton Truck	B 109 T	2143	359	5.9	0.17	S-8/JP-8
5 Ton Truck	B 110 T	2963	583	5.1	0.20	S-8/JP-8
5 Ton Truck	B 111 T	3254	609	5.3	0.19	S-8/JP-8
5 Ton Truck	B 112 T	3304	569	5.8	0.17	S-8/JP-8
5 Ton Truck	B 117 C	2218	230	9.6	0.10	JP-8
5 Ton Truck	B 118 C	3107	500	6.2	0.16	JP-8
5 Ton Truck	B 119 C	3100	489	6.3	0.16	JP-8
5 Ton Truck	B 120C	3366	496	6.8	0.15	JP-8
2½ Ton LMTV	B 70 T	139	36	2.6	0.26	S-8/JP-8
2½ Ton LMTV	B 72 T	255	97	2.6	0.38	S-8/JP-8
2½ Ton LMTV	B 73 T	308	82	3.8	0.27	S-8/JP-8
2½ Ton LMTV	B 77 T	322	162	2.0	0.50	S-8/JP-8
2½ Ton LMTV	B 80 T	234	66	3.5	0.28	S-8/JP-8

2½ Ton LMTV	B 82 T	183	24	7.6	0.13	S-8/JP-8
2½ Ton LMTV	B 71 C	518	99	5.2	0.19	JP-8
2½ Ton LMTV	B 74 C	154	59	2.6	0.38	JP-8
2½ Ton LMTV	B 75 C	19	21	.90	1.11	JP-8
2½ Ton LMTV	B 84 C	602	105	5.7	0.17	JP-8
2½ Ton LMTV	B 87 C	27	15	1.8	0.56	JP-8
2½ Ton LMTV	B 88 C	8	0	n/a	n/a	JP-8
2½ Ton LMTV	B 89 C	1197	29	n/a	n/a	JP-8
5 Ton MTV	B 141 T	4652	852	5.5	0.18	S-8/JP-8
5 Ton MTV	B 144 T	2870	618	4.6	0.22	S-8/JP-8
5 Ton MTV	B 148 T	5085	1024	9.6	0.20	S-8/JP-8
5 Ton MTV	B 150 T	3681	738	5.0	0.20	S-8/JP-8
5 Ton MTV	B 154 T	3657	690	5.1	0.19	S-8/JP-8
5 Ton MTV	B 155 C	3199	624	5.1	0.20	JP-8
5 Ton MTV	B 160 C	4965	1033	4.8	0.21	JP-8
5 Ton MTV	B 161 C	5074	911	5.6	0.18	JP-8
5 Ton MTV	B 163 C	3885	765	5.1	0.20	JP-8
5 Ton MTV	B 159 C	1663	318	5.2	0.19	JP-8
Truck Tractor	B 55 T	356	192	1.9	0.54	S-8/JP-8
Truck Tractor	B 58 T	24	63	0.38	2.63	S-8/JP-8
Truck Tractor	B 65 T	767	284	2.7	0.37	S-8/JP-8
Truck Tractor	B 67 T	794	279	2.8	0.35	S-8/JP-8
Truck Tractor	B 126 T	486	134	3.6	0.28	S-8/JP-8
Truck Tractor	B 136 T	524	221	2.4	0.32	S-8/JP-8
Truck Tractor	B 137 T	689	212	3.3	0.30	S-8/JP-8
Truck Tractor	B 59 C	250	116	2.2	0.46	JP-8
Truck Tractor	B 66 C	327	127	2.6	0.39	JP-8
Truck Tractor	B 135 C	768	293	2.6	0.38	JP-8
Truck Tractor	B 138 C	922	355	2.6	0.39	JP-8
Wrecker MTV	B 301 T	1182	176	6.7	0.15	S-8/JP-8
Wrecker MTV	B 302 C	586	142	4.1	0.24	JP-8
Wrecker HEMTT	B 300 T	940	248	3.8	0.26	S-8/JP-8
Wrecker HEMTT	B93 C	1423	0	n/a	n/a	n/a

5.2 VEHICLE USAGE AND FUEL CONSUMPTION

The fuel economy was calculated from reported usage data and gallons of fuel consumed. Figure 18 shows the total mileage accumulation by vehicle type. The highest mileage accumulation for individual test vehicles was 5,085 miles and the lowest was 24 miles. Individual control vehicle high mileage accumulation was 5,074 miles and a low accumulation of 8 miles.

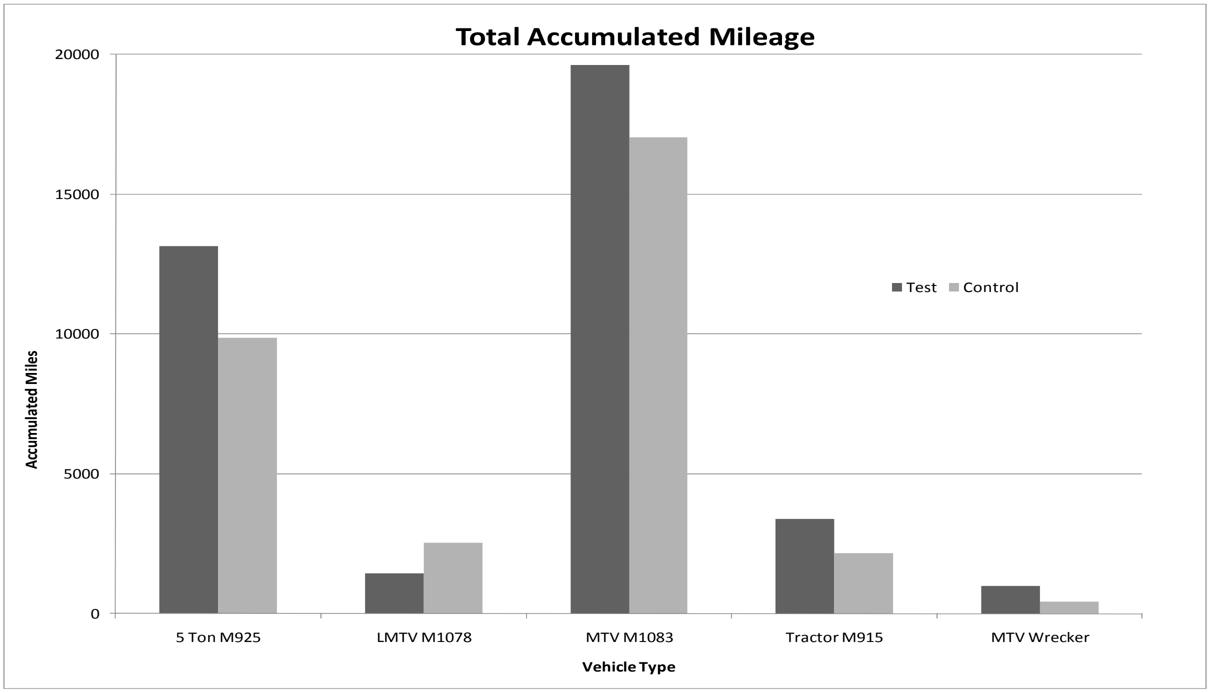

Figure 18 - Total Milage Accumulation by Vehicle Type

From the beginning of the demonstration program, it was known that the transportation driving school at Ft. Bliss was scheduled to be relocated to Ft. Leonard Wood, MO. Consolidation of assets with Ft. Leonard Wood began in January 2009 and several test and control vehicles were removed from the program. Some vehicles were added to attempt to maintain an even balance of same type vehicles. Table 9 shows test and control vehicles that were removed and added to the fleet during this transition period.

Table 9 - Test and Control Vehicles Added/Removed During Demonstration

Type Vehicle	Bumper Number	Disposition	Month
HMMWV	B2T	Added	November 08
HMMWV	B4T	Added	November 08
M915A4 Tractor	B55T	Removed	January 09
M915A4 Tractor	B58T	Removed	January 09
M915A4 Tractor	B126C	Added	November 08
M915A4 Tractor	B59C	Removed	January 09
M915A4 Tractor	B66C	Removed	January 09
M1078 LMTV	B80T	Removed	January 09
M1078 LMTV	B82T	Removed	January 09
M1078 LMTV	B77T	Removed	May 09
M1078 LMTV	B73T	Removed	May 09
M1078 LMTV	B72T	Removed	May 09
M1078 LMTV	B70T	Added	November 08
M1078 LMTV	B70T	Removed	May 09
M1078 LMTV	B71C	Removed	January 09
M1078 LMTV	B74C	Added	November 08
M1078 LMTV	B75C	Added	November 08
M1078 LMTV	B87C	Removed	January 09
M1078 LMTV	B88C	Removed	January 09
M1078 LMTV	B89C	Removed	January 09
M1083A1 MTV	B159C	Removed	January 09
M978 HEMTT	B93C	Removed	April 09

Figure 19 is a presentation of fuel economy by vehicle type. The data shows a difference in fuel economy of approximately 0-1.5 miles per gallon drop in fuel efficiency when using synthetic fuel blend compared to 100% JP-8.

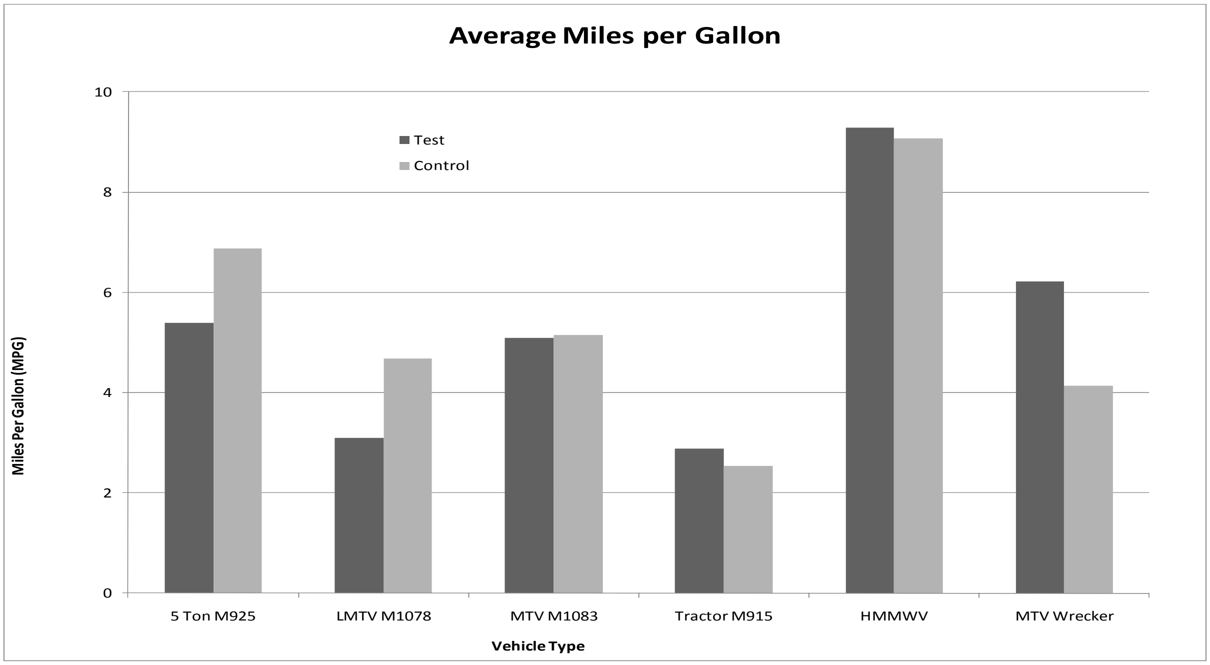

Figure 19 - Average Miles Per Gallon by Vehicle Type

5.3 FUEL SYSTEM COMPONENT REPLACEMENT

5.3.1 Stanadyne DB2 Rotary Injection pump

Five different fuel systems used in the power plants tested during the demonstration program were identified. The Stanadyne rotary injection pump fueling the 6.2L and 6.5L GEP engine powering the HMMWV truck historically has shown sensitivity to fuels with low viscosity kerosene based fuels such as JP-8. Therefore, blending 48% FT SPK with lower viscosity than JP-8 was a valid concern during the demonstration program. Four HMMWV trucks were made available to use for the demonstration program. Three were designated as test vehicles and new injection pumps were installed at the onset of the demonstration program. Prior to installation the pumps were flow tested and calibrated at a local independent diesel injection shop and the results were recorded to be used later as baseline comparison when the new pumps were removed at the end of the program to determine effects of blended fuel on vehicle fuel system. Since the HMMWV trucks were used as support vehicles and not as driver's test vehicles, mileage accumulation was minimal with the exception of one vehicle. Vehicle B03 logged 5,000 miles during the program using the fuel blend and was the only one of the three that warranted post-test removal of the injection pump for recalibration and inspection. The injection pump removed at the beginning of the demonstration was re-installed in vehicle B03. The following are pressures and fuel flows at the various speeds that were out of specification when the pump was recalibrated:

- Transfer pump psi at 1000 rpm came in at 65 psi which is 3 psi over the specification of 60-62
- Low idle at 350 rpm changed from 16 cc to 0 cc from a specification of 12-16 cc.

  Note: Investigation revealed that this was an intermittent problem caused by a sticking fuel cut off solenoid. This issue was not attributed to the use of the synthetic fuel blend..
- Fuel delivery at 1750 rpm change from the initial 45 cc to 43 which is -1.5 cc from the specification of 44.5-47.5 cc.
- Also at 1750 rpm, the advance changed from the initial 4.25 deg. to 3.3 deg. Which is -0.45 from the specification of 3.75 to 4.75.
- Fuel delivery at 1900 rpm changed from 40 cc to 31 cc that resulted in -0.5 cc below the specification of 31.5 cc minimum.
- Face cam advance at 1600 rpm change from 4.5 deg to 2.75 deg for a -1.3 deg. from an expected specification of 4-6 deg.
- At 1800 rpm, fuel delivery changed from 45 cc to 42 cc resulting in a 3 cc difference from an expected specification of 44 cc minimum.

It is not uncommon for an injection pump to reveal out of specification parameter readings when calibrated after operating several thousand miles with JP-8 fuel. The slightly out of specification parameters shown above for the pump operated with the synthetic fuel blend would not have been noticed under in-vehicle driving operations and, neither vehicle operators nor maintenance personnel reported any drivability problems. The majority of the out of specification parameters reported here can be attributed to normal wear between the advance piston and piston bore. This wear experienced explains the drop in fuel delivery seen in the 1750, 1900, and 1800 rpm test points, as well as the loss in advance in the 1750 and 1600 test points. Table 10 shows the results of pre- and post-test calibration results. Bold numbers are out of specification results.

Table 10 - Pre and Post- Test Injection Pump Calibration Results

Stanadyne Pump Calibration / Evaluation					
Pump Type : DB2831- 5209 (arctic)				**SN: 14193182**	
Test condition : WD23 Field Demonstration from 6.2NA HMMWV					
PUMP RPM	***Description***	***Spec.***	***Before***	***After***	***Change***
1000	Transfer pump psi.	60-62 psi	60	**65**	5
	Return Fuel	225-375 cc	310	350	40
	Fuel Delivery	51.5 cc. Max.	47	47	0
350	Low Idle	12-16 cc	16	**0**	16
	Housing psi.	8-12 psi	11	10	1
	Cold Advance Solenoid	0-1 psi	0.5	0.5	0
1750	Fuel Delivery	44.5 - 47.5 cc	45	**43**	2
	Advance	3.75 - 4.75 deg.	4.25	**3.3**	0.95
1900	Fuel Delivery	31.5 cc min.	40	**31**	9
1600	Face Cam Fuel delivery	21.5 - 23.5 cc	23	22	1
	Advance	4 - 6 deg.	4.5	**2.75**	1.75
1800	Fuel Delivery	44 cc min.	45	**42**	3
	Transfer pump psi.	Record	89	96	7
	Housing psi.	Record	12	10	2
2025	High Idle	15 cc max.	8	10	2
	Transfer pump psi.	125 psi max.	104	106	2
200	Fuel Delivery	40 cc min.	42	42	0
	Shut-Off	4 cc max.	0.5	0.5	0
75	Fuel Delivery	26 cc min.	31	32	1
	Transfer pump psi.	16 psi min.	18	27	9
	Air Timing	-1 deg. (+/-.5)		-1	
	Date		8/6/2008	7/1/2009	

5.3.2 Fuel Injector Model NA52X

Along with the injection pumps, new Model NA52X injectors were installed at the onset of the demonstration on the three designated test vehicles. Prior to installation the injectors were flow tested using calibration fluid and the results were recorded to be used later as baseline comparison when the injectors were removed from the vehicle at the end of the program to determine effects, if any, of blended fuel on the vehicle fuel system. All injectors met required specifications and passed all inspections.

Fuel injector nozzle tests were performed in accordance with procedures set forth in Technical Manual for the 6.2L & 6.5L GEP diesel engines [7] using diesel nozzle tester J 29075 – B. Nozzle testing is comprised of the following checks:

- Nozzle Opening Pressure
- Leakage
- Chatter
- Spray Pattern

Each test is considered independent of the others, and if any one of the tests is not satisfied, the injector should be replaced.

The normal opening pressure specification for these injectors is 1500 psig minimum. The specified nozzle leakage test involves pressurizing the injector nozzle to 1400 psig and holding for 10 seconds – no fuel droplets should separate from the injector tip. The chatter and spray pattern evaluations are subjective. A sharp audible chatter from the injector and a finely misted spray cone are required. As shown in Table 11, all injectors removed from vehicle B03 passed all specification parameters of pre-test and post-test requirements.

Table 11 - Injector Nozzle Test Results

Pre-Test Date: 7/24/2008 Fuel AF-6809 Post-Test Date: 9/10/2009 Fuel AF-6809 Injection Pump SN: 14193182									
Injector No.	Opening Pressure 1500 psig min		Leakage Test No drops for 10 sec. @ 1400 psig.		Chatter Test Audible Chatter		Spray Pattern Fine Spray		
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
T1	1875	1825	Pass	Pass	Pass	Pass	Pass	Pass
T2	1850	1750	Pass	Pass	Pass	Pass	Pass	Pass
T3	1900	1800	Pass	Pass	Pass	Pass	Pass	Pass
T4	1825	1700	Pass	Pass	Pass	Pass	Pass	Pass
T5	1850	1800	Pass	Pass	Pass	Pass	Pass	Pass
T6	1875	1825	Pass	Pass	Pass	Pass	Pass	Pass
T7	1900	1825	Pass	Pass	Pass	Pass	Pass	Pass
T8	1850	1750	Pass	Pass	Pass	Pass	Pass	Pass

5.4 VEHICLE PERFORMANCE

The performance of the test vehicles was assessed by soliciting the opinions of driver instructors, maintenance personnel, and when possible, the drivers themselves. No drivability problems were reported at any time during the program while operating on the blend of JP-8 and FT SPK. No maintenance actions were performed on the test vehicles as a result of synthetic blend use nor were there any leaks observed on fuel system components throughout the program.

5.5 FUEL QUALITY ANALYSIS

The selected test vehicles were not defueled and refueled with the test blend; instead, the fuel tanks were drawn down as much as possible during normal operations and the test blend was introduced and comingled with JP-8 fuel. Beginning in September 2008, TFLRF staff started obtaining one-gallon samples from each of the test vehicles and a randomly selected control vehicle from each control vehicle group. Also, samples were obtained from the 5,000 gallon fuel tanker that contained the test blend and the motor pool 10,000 gallon bulk tank containing the

JP-8 fuel used in the control vehicles. The samples were shipped from Ft. Bliss to TFLRF for typical property analyses to insure that the bulk JP-8 and FT SPK/JP-8 fuel blend used in the test and control vehicles was in compliance with aviation turbine fuel specifications. All samples obtained and analyzed met the specification. Individual vehicle samples were analyzed for viscosity, sulfur, and density values. The amount of blended fuel in test vehicle fuel tanks was determined by tracking total sulfur levels in vehicle fuel tanks and comparing it to bulk control and synthetic fuel blend. Figure 16 depicts the averaged test vehicle fuel tank turnover rate by vehicle type. Results of all analyses performed on individual vehicle and bulk fuel samples can be seen in Appendix B.

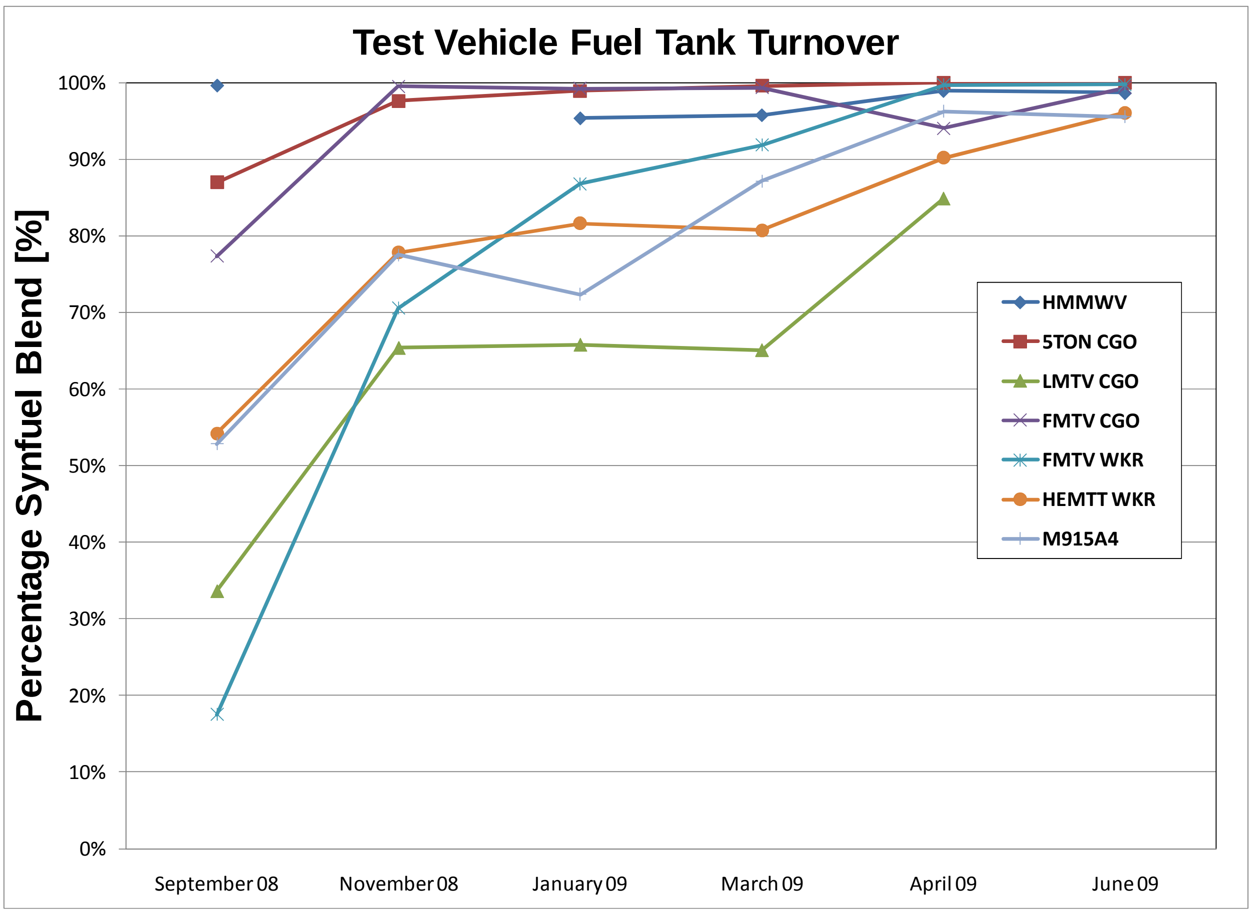

Figure 20 - Test Vehicle Fuel Tank Turnover

5.6 SMOKE OPACITY EVALUATIONS

Smoke opacity readings at transmission stall rpm were obtained at start of test and then quarterly thereafter and compared. It was expected that the cleaner burning characteristics of synthetic fuel would reduce smoke opacity readings, however, readings were not consistent with either fuel and results did not confirm this hypothesis.

6.0 CONCLUSIONS

The U.S. military, as the world's largest fuel consumer is pursuing the use of synthetic fuels in order to lessen the dependence in foreign oil and reduce the environmental impact. The use of approximately 50% volume blend of FT SPK and JP-8 in six different tactical wheeled vehicle family groups at Ft. Bliss, Texas, resulted in a very successful demonstration and confirmed that the operation of tactical vehicles in support of post, camp or station operations is feasible and prudent.

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APPENDIX A

FT. BLISS, TX, TEST AND CONTROL VEHICLE USAGE DATA

TEST VEHICLES										
Vehicle Type	Bumper No.	Start Miles 31-Jul-08	Miles 30-Sep-08	Miles 21-Nov-08	Miles 23-Jan-09	Miles 4-Mar-09	Miles 30-Apr-09	Miles 19-Jun-09	Cumulative Miles	Gallons Through 19-Jun-09
TRK UTIL HMMWV M998	B03 T	18024	18716	0	20933	21328	22545	22992	4968	483
TRK UTIL HMMWV M998	B02 T	134	0	134	285	323	441	499	365	63
TRK UTIL HMMWV M998	B04 T	199	0	199	397	405	484	520	321	63
TRK TRAC M915A4	B55 T	6052	6286	6408	0	0	0	0	356	192
TRK TRAC M915A4	B58 T	5570	5581	5594	0	0	0	0	24	63
TRK TRAC M915A4	B65 T	7281	7337	7548	7651	7755	7984	8048	767	284
TRK TRAC M915A4	B67 T	6211	6347	6346	6502	6682	6957	7005	794	279
TRK TRAC M915A4	B126T	11986	0	0	12053	12143	12381	12472	486	134
TRK TRAC M915A4	B136 T	9889	10098	10164	10216	10278	10375	10413	524	221
TRK TRAC M915A4	B137 T	11988	12289	12433	12508	12559	12667	12677	689	212
TRK CGO LMTV TON M1078	B70T	13421	0	0	13459	13485	13560	0	139	36
TRK CGO LMTV TON M1078	B72 T	11743	11880	11919	11937	11954	11998	0	255	97
TRK CGO LMTV TON M1078	B73 T	11520	11609	11710	11746	11778	11828	0	308	82
TRK CGO LMTV TON M1078	B77 T	11808	11915	12025	12053	12074	12130	0	322	162
TRK CGO LMTV TON M1078	B80 T	12468	12575	12610	12664	12683	12702	0	234	66
TRK CGO LMTV TON M1078	B82 T	10446	10497	10629	0	0	0	0	183	24
TRK CGO 5 TON M925A2	B107 T	31511	32164	33366	33551	33786	34348	34564	3053	612
TRK CGO 5 TON M925A2	B109 T	33430	34225	0	0	34675	35253	35573	2143	359
TRK CGO 5 TON M925A2	B110 T	33415	33831	34505	35246	35478	36010	36378	2963	583
TRK CGO 5 TON M925A2	B111 T	47653	48305	49106	49791	50030	50561	50907	3254	609
TRK CGO 5 TON M925A2	B112 T	36974	37592	38385	39144	39378	39950	40278	3304	569
TRK CGO MTV M1083A1	B141 T	7266	7577	9276	0	9813	11328	11918	4652	852
TRK CGO MTV M1083A1	B144 T	8155	8433	9393	9839	10416	11012	11025	2870	618
TRK CGO MTV M1083A1	B148 T	5414	5670	8430	9441	9986	10413	10499	5085	1024
TRK CGO MTV M1083A1	B150 T	9161	0	10190	11524	12190	13321	12842	3681	738
TRK CGO MTV M1083A1	B154 T	9915	10426	11396	12126	12799	13458	13572	3657	690
TRK WRK HEMTT M984A1	B300 T	11429	11437	11843	11948	11959	12076	12369	940	248
TRUCK WRECKER FMTV	B301 T	867	856	1109	1318	1466	1848	2049	1182	176

CONRTOL VEHICLES										
Vehicle Type	Bumper No.	Start Miles 31-Jul-08	Miles 30-Sep-08	Miles 21-Nov-08	Miles 23-Jan-09	Miles 4-Mar-09	Miles 30-Apr-09	Miles 19-Jun-09	Cumulative Miles	Gallons Through 19-Jun-09
TRK UTIL HMMWV M998	B01 C	27337	27390	27649	27992	28061	28218	28979	1642	181
TRK TRAC M915A4	B59 C	5165	5269	5415	0	0	0	0	250	116
TRK TRAC M915A4	B66 C	5678	5683	6005	0	0	0	0	327	127
TRK TRAC M915A4	B135 C	9853	10050	10204	10319	10361	10591	10621	768	293
TRK TRAC M915A4	B138 C	16253	16380	16628	16756	16852	17110	17175	922	355
TRK CGO LMTV TON M1078	B71 C	11743	11800	12261	0	0	0	0	518	99
TRK CGO LMTV TON M1078	B74C	11068	0	0	11090	11127	11222	0	154	59
TRK CGO LMTV TON M1078	B75C	12922	0	0	0	12941	12941	0	19	21
TRK CGO LMTV TON M1078	B84 C	11952	11951	12266	12377	12389	12554	0	602	105
TRK CGO LMTV TON M1078	B87 C	1818	1823	1845	0	0	0	0	27	15
TRK CGO LMTV TON M1078	B88 C	11237	11212	11245	0	0	0	0	8	0
TRK CGO LMTV TON M1078	B89 C	8930	9947	10127	0	0	0	0	1197	29
TRK FUEL TANK HEMTT M978	B93 C	18426	18693	19714	19792	19849	0	0	1423	0
TRK CGO 5 TON M925A2	B117 C	5084	5509	6359	0	0	0	7302	2218	230
TRK CGO 5 TON M925A2	B118 C	30976	31587	32281	32281	33082	33711	34083	3107	500
TRK CGO 5 TON M925A2	B119 C	29632	30085	30829	31581	31825	32379	32732	3100	489
TRK CGO 5 TON M925A2	B120 C	24908	25554	26330	27123	27470	28031	28274	3366	496
TRK CGO MTV M1083A1	B155 C	5046	5355	6363	6708	6755	7700	8245	3199	624
TRK CGO MTV M1083A1	B159 C	9712	10551	11375	0	0	0	0	1663	318
TRK CGO MTV M1083A1	B160 C	10356	11806	12965	13994	14136	14754	15321	4965	1033
TRK CGO MTV M1083A1	B161 C	6406	7504	8330	9266	9784	10949	11480	5074	911
TRK CGO MTV M1083A1	B163 C	9973	10435	11338	12427	12867	13762	13858	3885	765
TRUCK WRECKER FMTV	B302 C	1129	1098	1133	1170	1186	1553	1715	586	142

APPENDIX B

CHEMICAL ANALYSES OF FORT BLISS, TX, FT SPK/JP-8 FUEL BLEND

Ft. Bliss, TX Sample Analyses 29 September - 3 October 2008

Property	Test Method	CL 08-00382 50/50 Blend 5000G Tanker	CL 08-00383 Motorpool Bulk JP8
Density, 15C (g/mL)	D4052	0.7906	0.8049
Kinematic Viscosity, 40C (cSt)	D445	1.19	1.25
Sulfur *(wt%)*	D2622	0.002	0.0982
Hydrocarbons by FIA	D1319		
Aromatic *(vol%)*		13.5	16.6
Olefin *(vol%)*		2.1	1.3
Saturates *(vol%)*		84.4	82.1
Heat of Combustion	D240		
GROSS *(BTU/lb)*		19913	19783
NET *(BTU/lb)*		18616	18524
Flash Point *(°F)*	D93	129	128
(°C)		53.9	53.3
SLBOCLE (g)	D6078	2950	2800
BOCLE (mm)	D5001	0.5	0.55
HFRR (µm)	D6079	713	789
Distillation *(°C)*	D86		
IBP		165.2	151.7
10		175.0	168.2
20		177.9	175.9
50		191.2	196.5
90		220.9	241.9
FBP		241.3	274.2
Cetane Number	D613	45.7	42.1
Calculated Cetane	D976	44.4	40.8
Particulate Contamination	D5452		
Total Volume (L)		1.00	1.00
Total Contamination (mg/L)		0.40	0.40
Water Content *(ppm)*	D6304	49	48
Sample File 080929-081003			
Cntrl Avg Sul 0.1123			

Sample No.	Bumper No.	Veh. Model/No.	Kinematic Viscosity, 40C (cSt)	Sulfur (wt%)	Density, 15C (g/mL)	*% of 50/50 Blend In Tank*
CL 08-00391	B01C	HMMWV	1.27	0.1133	0.8054	N/A
CL 08-00398	B03T	HMMWV	1.16	0.0024	0.7906	99.6%
CL 08-00394	B119C	5TON CGO	1.26	0.1068	0.8049	N/A
CL 08-00388	B110T	5TON CGO	1.2	0.0234	0.7934	80.6%
CL 08-00401	B107T	5TON CGO	1.17	0.0091	0.7916	93.6%
CL 08-00404	B111T	5TON CGO	1.16	0.008	0.7914	94.6%
CL 08-00409	B112T	5TON CGO	1.18	0.0142	0.7922	88.9%
CL 08-00396	B109T	5TON CGO	1.17	0.0273	0.7939	77.1%
CL 08-00405	B71C	LMTV CGO	1.25	0.1123	0.8057	N/A
CL 08-00392	B82T	LMTV CGO	1.29	0.1262	0.8063	0.0%
CL 08-00395	B77T	LMTV CGO	1.21	0.0439	0.7959	62.0%
CL 08-00400	B72T	LMTV CGO	1.21	0.0511	0.7962	55.5%
CL 08-00407	B80T	LMTV CGO	1.3	0.1169	0.8067	0.0%
CL 08-00408	B73T	LMTV CGO	1.18	0.0566	0.7979	50.5%
CL 08-00386	B155C	FMTV CGO	1.27	0.1048	0.8052	N/A
CL 08-00390	B141T	FMTV CGO	1.19	0.0064	0.7912	96.0%
CL 08-00397	B148T	FMTV CGO	1.17	0.0023	0.7906	99.7%
CL 08-00403	B150T	FMTV CGO	1.25	0.1228	0.8059	0.0%
CL 08-00410	B144T	FMTV CGO	1.17	0.0076	0.7909	94.9%
CL 08-00412	B154T	FMTV CGO	1.17	0.0065	0.7912	95.9%
CL 08-00385	B302C	FMTV WKR	1.3	0.1377	0.8066	N/A
CL 08-00411	B301T	FMTV WKR	1.25	0.093	0.8028	17.5%
CL 08-00384	B93C	HEMTT TKR	1.26	0.0952	0.8049	N/A
CL 08-00402	B300T	HEMTT WKR	1.22	0.0525	0.7982	54.2%
CL 08-00413	B135C	M915A4	1.38/1.26	0.1162	0.8055	N/A
CL 08-00387	B137T	M915A4	1.23	0.0531	0.7976	53.7%
CL 08-00389	B65T	M915A4	1.21	0.0285	0.7939	76.0%
CL 08-00393	B55T	M915A4	1.19	0.021	0.7931	82.8%
CL 08-00399	B58T	M915A4	1.27	0.1292	0.8065	0.0%
CL 08-00406	B136T	M915A4	1.22	0.0553	0.7975	51.7%

*% of 50/50 Blend In Tank Based on Measured Sulfur Values

Ft. Bliss, TX Sample Analyses 17 November – 21November 2008

Property	Test Method	CL08-00512 50/50 Blend 5000G Tanker	CL08-00513 Delivery Tanker Before Pumping	CL08-00511 Delivery Tanker After Pumping
Density, 15C (g/mL)	D4052	0.7836	0.7825	0.7826
Kinematic Viscosity, 40C (cSt)	D445	1.22	1.23	1.16
Sulfur *(wt%)*	D2622	0.0014	0.0014	0.0014
Hydrocarbons by FIA	D1319			
Aromatic *(vol%)*		11.3	10.5	10.5
Olefin *(vol%)*		2.1	1.8	2.5
Saturates *(vol%)*		86.6	87.7	87
Heat of Combustion	D240			
GROSS *(BTU/lb)*		IC	19956	19960
NET *(BTU/lb)*				
Flash Point *(°F)*	D93	126	125	125
(°C)		52.2	51.7	51.7
SLBOCLE (g)	D6078	1700	1900	1950
BOCLE (mm)	D5001	0.505	0.53	0.495
HFRR (µm)	D6079	0.667	0.649	0.620
Distillation *(°C)*	D86			
IBP		61.0	133.3	131.4
10		163.0	169.9	169.9
20		170.4	173.1	172.9
50		184.0	185.4	185.3
90		216.9	217.8	217.4
FBP		236.4	237.9	237.1
Cetane Number	D613	47.8	47.4	48.1
Calculated Cetane	D976	44.0	45.1	45
Particulate Contamination	D5452			
Total Volume (L)		1.00	1.00	0.40
Total Contamination (mg/L)		0.50	0.80	3.50
Water Content *(ppm)*	D6304	19	28	21
Sample File 081117-081121				
Cntrl avg sul 0.1086				

Sample No.	Bumper No.	Veh. Model/No.	Kinematic Viscosity, 40C (cSt)	Sulfur (wt%)	Density, 15C (g/mL)	*% of 50/50 Blend In Tank**
CL08-523	B01C	HMMWV	1.48	0.0993	0.8045	
N/A*	B03T	HMMWV	N/A*	N/A*	N/A*	N/A*
CL08-539	B117C	5TON CGO	1.36	0.1002	0.8047	
CL08-526	B110T	5TON CGO	1.3	0.0066	0.7886	95.2%
CL08-537	B107T	5TON CGO	1.25	0.0031	0.7882	98.4%
CL08-534	B111T	5TON CGO	1.11	0.0025	0.7878	99.0%
CL08-527	B112T	5TON CGO	1.26	0.0038	0.7886	97.8%
N/A*	B109T	5TON CGO	N/A*	N/A*	N/A*	N/A*
CL08-540	B89C	LMTV CGO	1.32	0.1104	0.8054	
CL08-528	B82T	LMTV CGO	1.68	0.0774	0.7995	29.1%
CL08-524	B77T	LMTV CGO	1.34	0.0307	0.7941	72.7%
CL08-515	B72T	LMTV CGO	1.31	0.0292	0.7939	74.1%
CL08-538	B80T	LMTV CGO	1.23	0.0247	0.7875	78.3%
CL08-522	B73T	LMTV CGO	1.3	0.0307	0.7942	72.7%
CL08-532	B161C	FMTV CGO	1.36	0.094	0.8046	
CL08-533	B141T	FMTV CGO	1.19	0.0017	0.7854	99.7%
CL08-530	B148T	FMTV CGO	1.17	0.0018	0.7865	99.6%
CL08-519	B150T	FMTV CGO	1.15	0.0019	0.766	99.5%
CL08-535	B144T	FMTV CGO	1.11	0.0019	0.7863	99.5%
CL08-536	B154T	FMTV CGO	1.33	0.0023	0.7906	99.2%
CL08-529	B302C	FMTV WKR	1.4	0.1395	0.8066	
CL08-518	B301T	FMTV WKR	1.32	0.033	0.7942	70.5%
CL08-531	B93C	HEMTT TKR	1.45	0.0944	0.8048	
CL08-516	B300T	HEMTT WKR	1.31	0.0252	0.7937	77.8%
CL08-520	B67C	M915A4	1.7	0.1227	0.8059	
CL08-517	B137T	M915A4	1.4	0.0195	0.7918	83.1%
CL08-521	B65T	M915A4	1.49	0.0147	0.7922	87.6%
CL08-525	B55T	M915A4	1.35	0.0123	0.7918	89.8%
CL08-541	B58T	M915A4	1.32	0.0581	0.7974	47.1%
CL08-514	B136T	M915A4	1.29	0.023	0.7933	79.9%

*% of 50/50 Blend In Tank Based on Measured Sulfur Values

Ft. Bliss, TX Sample Analyses January 19 – January 23 2009

Property	Test Method				
Density, 15C (g/mL)	D4052				
Kinematic Viscosity, 40C (cSt)	D445				
Sulfur *(wt%)*	D2622				
Hydrocarbons by FIA	D1319				
Aromatic *(vol%)*					
Olefin *(vol%)*					
Saturates *(vol%)*					
Heat of Combustion	D240				
GROSS *(BTU/lb)*					
NET *(BTU/lb)*					
Flash Point *(°F)*	D93				
(°C)					
SLBOCLE (g)	D6078				
BOCLE (mm)	D5001				
HFRR (µm)	D6079				
Distillation *(°C)*	D86				
IBP					
10					
20					
50					
90					
FBP					
Cetane Number	D613				
Calculated Cetane	D976				
Particulate Contamination	D5452				
Total Volume (L)					
Total Contamination (mg/L)					
Water Content *(ppm)*	D6304				

Sample File 090119-090123

Cntrl avg sul 0.1

Bumper No.	Veh. Model/No.	Kinematic Viscosity, 40C (cSt)	Sulfur (wt%)	Density, 15C (g/mL)	*% of 50/50 Blend In Tank**
B01C	HMMWV	1.3	0.0979	0.806	
B03T	HMMWV	1.16	0.0022	0.7835	99.2%
B02T	HMMWV	1.22	0.002	0.7898	99.4%
B04T	HMMWV	1.19	0.0137	0.7907	87.5%
B118C	5TON CGO	1.31	0.0932	0.8054	
B110T	5TON CGO	1.16	0.0025	0.7837	98.9%
B107T	5TON CGO	1.14	0.0024	0.7837	99.0%
B111T	5TON CGO	1.22	0.0023	0.7837	99.1%
B112T	5TON CGO	1.17	0.0026	0.7839	98.8%
B109T	5TON CGO	N/A	N/A	N/A	N/A
B74C	LMTV CGO	1.3	0.1024	0.8053	
B70T	LMTV CGO	1.27	0.1002	0.8053	0.0%
B72T	LMTV CGO	1.21	0.0292	0.7938	71.8%
B73T	LMTV CGO	1.15	0.0146	0.7881	86.6%
B77T	LMTV CGO	1.22	0.0168	0.7889	84.4%
B80T	LMTV CGO	1.17	0.015	0.7858	86.2%
B163C	FMTV CGO	1.29	0.0932	0.8056	
B141T	FMTV CGO	N/A	N/A	N/A	N/A
B148T	FMTV CGO	1.14	0.0022	0.7834	99.2%
B150T	FMTV CGO	1.17	0.0022	0.7835	99.2%
B144T	FMTV CGO	1.13	0.0021	0.7836	99.3%
B154T	FMTV CGO	1.17	0.0023	0.7875	99.1%
B302C	FMTV WKR	1.31	0.1256	0.8066	
B301T	FMTV WKR	1.2	0.0144	0.7879	86.8%
B93C	HEMTT TKR	1.25	0.0885	0.8047	
B300T	HEMTT WKR	1.18	0.0195	0.7914	81.6%
B135C	M915A4	1.31	0.0989	0.8057	
B65T	M915A4	1.19	0.0299	0.7916	71.1%
B67T	M915A4	1.17	0.011	0.7851	90.3%
B126T	M915A4	1.23	0.0659	0.7973	34.6%
B136T	M915A4	1.19	0.0232	0.7952	77.9%
B137T	M915A4	1.17	0.0132	0.7887	88.0%

*% of 50/50 Blend In Tank Based on Measured Sulfur Values

** N/A denotes vehicles that were unavailable for fuel sampling

Ft. Bliss, TX Sample Analyses 2 March – 6 March 2009

Property	Test Method	Delivery Tanker	50/50 Blend 5000G Tanker	Motorpool JP8
Density, 15C (g/mL)	D4052	0.7808	0.7834	0.805
Kinematic Viscosity, 40C (cSt)	D445	1.11	1.14	1.28
Sulfur *(wt%)*	D2622	0.0066	0.0021	0.0857
Hydrocarbons by FIA	D1319			
Aromatic *(vol%)*		10	11.4	16.7
Olefin *(vol%)*		2.4	1.8	2.9
Saturates *(vol%)*		87.6	68.8	80.7
Heat of Combustion	D240			
GROSS *(BTU/lb)*		20008	19979.3	19780
NET *(BTU/lb)*		18696.1	18673.7	18528.3
Flash Point *(°F)*	D93	119.3	121.1	108.5
(°C)		48.5	49.5	42.5
SLBOCLE (g)	D6078	2450	2000	2800
BOCLE (mm)	D5001	0.5	0.5	0.52
HFRR (µm)	D6079	0.674	0.679	0.680
Distillation *(°C)*	D86			
IBP		72.7	82.2	76.3
10		161.1	164.6	157.1
20		168.0	169.4	168.9
50		182.3	183.6	192.1
90		216.9	216.4	239
FBP		238.5	236	266.8
Cetane Number	D613	47.8	46.9	44.6
Calculated Cetane	D976	44.3	43.9	39
Particulate Contamination	D5452			
Total Volume (L)		1.00	1.00	1.00
Total Contamination (mg/L)		1.50	0.40	1.20
Water Content *(ppm)*	D6304	27	42	30

Sample File 090302-090306
Cntrl avg sul 0.0929

Bumper No.	Veh. Model/No.	Kinematic Viscosity, 40C (cSt)	Sulfur (wt%)	Density, 15C (g/mL)	*% of 50/50 Blend In Tank**
B01C	HMMWV	1.24	0.0905	0.8053	
B03T	HMMWV	1.15	0.0023	0.7835	99.8%
B02T	HMMWV	1.17	0.0021	0.7872	100.0%
B04T	HMMWV	1.20	0.0134	0.7909	87.6%
B119C	5TON CGO	1.25	0.0890	0.8053	
B110T	5TON CGO	1.14	0.0024	0.7835	99.7%
B107T	5TON CGO	1.15	0.0024	0.7836	99.7%
B111T	5TON CGO	1.12	0.0022	0.7836	99.9%
B112T	5TON CGO	1.14	0.0025	0.7836	99.6%
B109T	5TON CGO	1.16	0.0031	0.7845	98.9%
B74C	LMTV CGO	1.26	0.0999	0.8053	
B70T	LMTV CGO	1.25	0.1002	0.8054	0.0%
B72T	LMTV CGO	1.20	0.0290	0.7939	70.4%
B73T	LMTV CGO	1.19	0.0148	0.7881	86.0%
B77T	LMTV CGO	1.21	0.0171	0.7891	83.5%
B80T	LMTV CGO	1.19	0.0152	0.7858	85.6%
B161C	FMTV CGO	1.29	0.0862	0.8050	
B141T	FMTV CGO	1.15	0.0023	0.7833	99.8%
B148T	FMTV CGO	1.15	0.0024	0.7834	99.7%
B150T	FMTV CGO	1.19	0.0031	0.7830	98.9%
B144T	FMTV CGO	1.14	0.0023	0.7833	99.8%
B154T	FMTV CGO	1.16	0.0035	0.0783	98.5%
B302C	FMTV WKR	1.29	0.1087	0.8057	
B301T	FMTV WKR	1.14	0.0095	0.7860	91.8%
B93C	HEMTT TKR	1.35	0.0869	0.8049	
B300T	HEMTT WKR	1.19	0.0196	0.7913	80.7%
B138C	M915A4	1.25	0.0890	0.8040	
B65T	M915A4	1.18	0.0146	0.7867	86.2%
B67T	M915A4	1.14	0.0051	0.7840	96.7%
B126T	M915A4	1.17	0.0209	0.7874	79.3%
B136T	M915A4	1.20	0.0162	0.7896	84.5%
B137T	M915A4	1.16	0.0122	0.7881	88.9%

*% of 50/50 Blend In Tank Based on Measured Sulfur Values
** N/A denotes vehicles that were unavailable for fuel sampling

Ft. Bliss, TX Sample Analyses – 27 April – 30 April 2009

Property	Test Method	50/50 Blend 5000G Tanker	Motorpool JP8
Density, 15C (g/mL)	D4052	0.7817	0.8049
Kinematic Viscosity, 40C (cSt)	D445	1.13	1.34
Sulfur *(wt%)*	D2622	0.0054	0.0904
Hydrocarbons by FIA	D1319		
Aromatic *(vol%)*		10.9	16.9
Olefin *(vol%)*		0.7	1.2
Saturates *(vol%)*		88.4	81.9
Heat of Combustion	D240		
GROSS *(BTU/lb)*		20043.9	19785.6
NET *(BTU/lb)*		18711.9	18506.5
Flash Point *(°F)*	D93	120	113
(°C)		49	45
SLBOCLE (g)	D6078	2400	2500
BOCLE (mm)	D5001	0.52	0.53
HFRR (µm)	D6079	0.672	0.666
Distillation *(°C)*	D86		
IBP		162.4	152.5
10		171.3	169.4
20		174.5	177.2
50		187.5	197.7
90		221.8	246.1
FBP		244.8	278.8
Cetane Number	D613	48.1	45.8
Calculated Cetane	D976	46.5	41.5
Particulate Contamination	D5452		
Total Volume (L)		1	1
Total Contamination (mg/L)		0.8	1.4
Water Content *(ppm)*	D6304	52	46

Sample File 090427-090430
Cntrl avg sul 0.09285

Bumper No.	Veh. Model/No.	Kinematic Viscosity, 40C (cSt)	Sulfur (wt%)	Density, 15C (g/mL)	*% of 50/50 Blend In Tank**
B01C	HMMWV	1.28	0.0923	0.8052	
B03T	HMMWV	1.14	0.0052	0.7817	100.0%
B02T	HMMWV	1.23	0.0038	0.7845	100.0%
B04T	HMMWV	1.19	0.0082	0.7843	96.8%
B120C	5TON CGO	1.29	0.0918	0.8051	
B110T	5TON CGO	1.26	0.0047	0.7821	100.0%
B107T	5TON CGO	1.22	0.0054	0.7819	100.0%
B111T	5TON CGO	1.16	0.0048	0.782	100.0%
B112T	5TON CGO	1.16	0.0049	0.782	100.0%
B109T	5TON CGO	1.15	0.005	0.7821	100.0%
B84C	LMTV CGO	1.27	0.0974	0.8055	
B70T	LMTV CGO	1.2	0.0434	0.7904	56.5%
B72T	LMTV CGO	1.19	0.0154	0.7863	88.6%
B73T	LMTV CGO	1.19	0.0119	0.7857	92.6%
B77T	LMTV CGO	1.13	0.0065	0.7822	98.7%
B80T	LMTV CGO	1.24	0.0159	0.7859	88.0%
B155C	FMTV CGO	1.26	0.0909	0.805	
B141T	FMTV CGO	1.24	0.0314	0.7886	70.3%
B148T	FMTV CGO	1.12	0.005	0.7819	100.0%
B150T	FMTV CGO	1.15	0.0054	0.7817	100.0%
B144T	FMTV CGO	1.16	0.0055	0.7818	99.9%
B154T	FMTV CGO	1.15	0.0053	0.7817	100.0%
B302C	FMTV WKR	1.29	0.093	0.8051	
B301T	FMTV WKR	1.15	0.0057	0.7822	99.7%
B93C	HEMTT TKR	N/A**	N/A**	N/A**	
B300T	HEMTT WKR	1.19	0.014	0.7872	90.2%
B135C	M915A4	1.28	0.0917	0.8051	
B65T	M915A4	1.22	0.0074	0.7828	97.7%
B67T	M915A4	1.15	0.0055	0.7821	99.9%
B126T	M915A4	1.16	0.0095	0.7831	95.3%
B136T	M915A4	1.14	0.0117	0.7861	92.8%
B137T	M915A4	1.19	0.0094	0.7855	95.4%

*% of 50/50 Blend In Tank Based on Measured Sulfur Values
** N/A denotes vehicles that were unavailable for fuel sampling

Ft. Bliss, TX Sample Analyses 15 June – 19 June 2009

Property	Test Method	50/50 Blend 5000G Tanker	Motorpool JP8
Density, 15C (g/mL)	D4052	0.7818	0.805
Kinematic Viscosity, 40C (cSt)	D445	1.13	1.25
Sulfur (wt%)	D2622	0.0053	0.0894
Hydrocarbons by FIA	D1319		
Aromatic (vol%)		9.9	16.1
Olefin (vol%)		1.2	1
Saturates (vol%)		88.9	82.9
Heat of Combustion	D240		
GROSS (BTU/lb)		19968.6	19776.8
NET (BTU/lb)		18650.3	18509.5
Flash Point (°F)	D93	120	109
(°C)		49	43
SLBOCLE (g)	D6078	1925	2625
BOCLE (mm)	D5001	0.51	0.54
HFRR (µm)	D6079	0.752	0.760
Distillation (°C)	D86		
IBP		161.5	152.8
10		171.4	170.4
20		175.2	177.6
50		187.6	197.8
90		223.3	247.9
FBP		245.4	279.8
Cetane Number	D613	48.3	43.7
Calculated Cetane	D976	46.5	41.6
Particulate Contamination	D5452		
Total Volume (L)		0.5	0.5
Total Contamination (mg/L)		0.6	1.2
Water Content (ppm)	D6304	76	77

Sample File 090615-090619
Cntrl avg sul 0.0866

Bumper No.	Veh. Model/No.	Kinematic Viscosity, 40C (cSt)	Sulfur (wt%)	Density, 15C (g/mL)	*% of 50/50 Blend In Tank**
B01C	HMMWV	1.28	0.0872	0.8042	
B03T	HMMWV	1.14	0.0056	0.7816	99.6%
B02T	HMMWV	1.16	0.0042	0.7845	100.0%
B04T	HMMWV	1.17	0.0083	0.7843	96.3%
B120C	5TON CGO	1.27	0.0919	0.8053	
B110T	5TON CGO	1.14	0.0053	0.7818	100.0%
B107T	5TON CGO	1.15	0.0055	0.7817	99.8%
B111T	5TON CGO	1.12	0.0051	0.7819	100.0%
B112T	5TON CGO	1.15	0.005	0.7818	100.0%
B109T	5TON CGO	1.12	0.0054	0.7819	99.9%
B84C	LMTV CGO				
B70T	LMTV CGO	N/A			
B72T	LMTV CGO	N/A			
B73T	LMTV CGO	N/A			
B77T	LMTV CGO	N/A			
B80T	LMTV CGO	N/A			
B155C	FMTV CGO	1.28	0.0903	0.8046	
B141T	FMTV CGO	1.14	0.0077	0.7824	97.0%
B148T	FMTV CGO	1.14	0.0051	0.7819	100.0%
B150T	FMTV CGO	1.13	0.0056	0.7817	99.6%
B144T	FMTV CGO	1.13	0.0053	0.7817	100.0%
B154T	FMTV CGO	1.14	0.005	0.7817	100.0%
B302C	FMTV WKR	1.23	0.0709	0.7795	
B301T	FMTV WKR	1.13	0.0055	0.7819	99.8%
B93C	HEMTT TKR	N/A			
B300T	HEMTT WKR	1.14	0.0085	0.7836	96.1%
B135C	M915A4	1.26	0.0927	0.8051	
B65T	M915A4	1.15	0.008	0.7824	96.7%
B67T	M915A4	1.14	0.0059	0.7818	99.3%
B126T	M915A4	1.15	0.0095	0.7831	94.8%
B136T	M915A4	1.18	0.0119	0.7863	91.9%
B137T	M915A4	1.16	0.0095	0.7854	94.8%
*% of 50/50 Blend In Tank Based on Measured Sulfur Values					
** N/A denotes vehicles that were unavailable for fuel sampling					